FCC Advisory Committee on Advanced Television Service

APPENDIX VIII

TEST SEQUENCE & CALENDAR

for Laboratory Testing of Advanced Television (ATV) Transmission Systems
by the Advanced Television Test Center & Cable Television Laboratories

Move In 10 working days before — Move Out 5 working days after

ATV SYSTEM ACCESS PERIOD	INTERFACE CHECK	LABORATORY TEST PERIOD: START TESTING	LABORATORY TEST PERIOD: END TESTING	ATV SYSTEM/ PROPONENT	SCANNING FORMAT (see item 3, below)
	1991				
1	April 8	April 12	June 12	ACTV: Advanced Compatible Television David Sarnoff Research Center	525/59.94, 1:1
2	June 13	June 19	August 12	Narrow MUSE NHK/Japan Broadcasting Corporation	1125/60, 2:1
3	August 27	September 3	October 24	DigiCipher General Instrument Corporation	1050/59.94, 2:1
4	October 25	October 31	December 27	SC-HDTV: Spectrum Compatible HDTV* Zenith Electronics Corporation	787.5/59.94, 1:1
	1992				
5	December 30	January 8	March 3	Analog Simulcast HDTV* N.A. Philips Consumer Electronics Co.	1050/59.94, 2:1
6	March 4	March 10	April 30	Channel Compatible HDTV Massachusetts Institute of Technology	787.5/59.94, 1:1

*Zenith and Philips/Advanced Television Research Consortium have announced that they will replace the analog systems listed here (and precertified by SS/WP-1) with digital systems. Testing of the digital systems is subject to Pre- and Final Certification. (See notes 4, 5, 8, below.)

Notes:

- MOVE IN: Proponent permitted to begin moving certified ATV system's equipment into ATTC facility and setting up 10 working days prior to beginning INTERFACE CHECK: ATTC's electric power and HVAC systems will be in operation.
- INTERFACE CHECK: From this date, ATTC prepared to supply video, audio, and other specified signals to ATV system as previously agreed; each system permitted up to four working days prior to test start for proponent and ATTC/CableLabs to verify signal interface parameters.
- MOVE OUT: Proponent permitted up to five working days after end of testing to remove all of its equipment and belongings from ATTC facility.

See "ATTC Test Administration Plan & Operations Manual" and related contract for full definitions, terms, and conditions.

This Test Sequence & Calendar is based on the following conditions:

1. Dates are final commitments from proponents for delivery of ATV systems. Upon withdrawal or merger of any of the scheduled ATV systems, those systems scheduled for subsequent slots may be advanced, upon reasonable notice, by one test slot (ATV System Access Period). The testing process and laboratories require a testing schedule that promises reasonably continuous use of laboratory facilities and avoids significant downtime between systems.

2. Each system must operate with the source signal Scanning Format previously committed to by its proponent to ATTC (listed above)--*e.g.* number of scanning lines/cycles per second, progressive (1:1) or interlaced (2:1). Official test material in these formats is to be produced, approved, and delivered to ATTC by the Advisory Committee sufficiently in advance of testing.

3. This schedule reflects a currently estimated 38 working days (for simulcast HDTV systems) and 43 working days (for enhanced NTSC systems) for ATTC and CableLabs to conduct the laboratory tests for broadcast and cable. It does not reflect: a) subjective rating tests (video and audio); b) field tests in the actual transmission environment; or c) retesting. Subjective rating tests are planned to be conducted off-line and at other facilities; they will start after video and audio tape records for a particular ATV system's rating tests have been completed at ATTC.

4. Each ATV system must be certified for testing by the Advisory Committee (SS/WP-1). A system's full technical documentation for Final Certification must be submitted by the proponent to SS/WP-1 ninety (90) days prior to the arrival of the system at ATTC (MOVE IN) for testing, and Final Certification must be completed by sixty (60) days prior to the arrival of the system at ATTC for testing. Final Certification through this Advisory Committee process is a prerequisite for a system's being tested by ATTC and CableLabs.

1991-92 Key Dates in the Test Schedule of the Advanced Television Test Center, Cable Television Laboratories, & Advanced Television Evaluation Laboratory

SYSTEM PROPONENT	DATES[1]							
	ACATS Final Certification[2]	Earliest Move-in at ATTC	Begin Interface Check	Start ATTC Testing	Begin Subjective Tests[4]	End ATTC Testing	Latest Move-out from ATTC	End Subjective Tests[4]
Advanced Compatible Television (ACTV) David Sarnoff Research Center	Wednesday Jan. 16, '91	Monday Mar. 25, '91	Monday Apr. 8, '91	Friday Apr. 12, '91	Friday May 10, '91	Wednesday June 12, '91	Wednesday June 19, '91	Friday July 5, '91
Narrow MUSE NHK (Japan Broadcasting Corporation)	Tuesday Mar. 26, '91	Wednesday May 29, '91	Thursday June 13, '91	Wednesday June 19, '91	Wednesday July 17, '91	Monday Aug. 12, '91	Monday Aug. 19, '91	Wednesday Sept. 11, '91
DigiCipher General Instrument Corporation	Friday June 7, '91	Tuesday Aug. 13, '91	Tuesday Aug. 27, '91	Tuesday Sept. 3, '91	Tuesday Oct. 1, '91	Thursday Oct. 24, '91	Thursday Oct. 31, '91	Tuesday Nov. 26, '91
Spectrum Compatible HDTV (SC-HDTV) Zenith Electronics Corporation	Wednesday Aug. 7, '91	Friday Oct. 11, '91	Friday Oct. 25, '91	Thursday Oct. 31, '91	Thursday Nov. 28, '91	Friday Dec. 27, '91	Monday Jan. 6, '92	Thursday Feb. 6, '92
Analog Simulcast HDTV[3] N.A. Philips Consumer Electronics Co.	Monday Oct. 7, '91	Thursday Dec. 12, '91	Monday Dec. 30, '91	Wednesday Jan. 8, '92	Friday Feb. 7, '92	Tuesday Mar. 3, '92	Tuesday Mar. 10, '92	Friday Apr. 3, '92
Channel Compatible HDTV[3] Massachusetts Institute of Technology	Thursday Dec. 5, '91	Wednesday Feb. 19, '92	Wednesday March 4, '92	Tuesday Mar. 10, '92	Tuesday Apr. 7, '92	Thursday Apr. 30, '92	Thursday May 7, '92	Tuesday June 2, '92

1. "Interface Check" dates and dates for "Testing" are taken from the FCC Advisory Committee on Advanced Television Service "Test Sequence and Calendar" (11/14/90, rev 1/7/91).
2. "Final Certification" is the date by which SS/WP-1 is to complete its full 'paper' technical analysis and grant final certification of the system for testing, 60 days prior to the arrival of the system at ATTC for testing.
3. Zenith and Philips/Advanced Television Research Consortium have announced that they will replace the analog systems listed here (and precertified by SS/WP-1) with digital systems. Acceptance for testing of the digital systems is subject to pre- and final certification by SS/WP-1. [See FCC Advisory Committee on Advanced Television Service "Test Sequence and Calendar" (Rev 1/7/91), notes 4, 5, and 6.]
4. Subjective testing is to be conducted by the Advanced Television Evaluation Laboratory (Communications Research Centre, Canada).

ATTC/CableLabs/ATEL 1/7/91

TAB

ADVANCED TELEVISION TEST CENTER, INC.

SSWP2-0646
18 JAN 91

1330 BRADDOCK PLACE SUITE 200 ALEXANDRIA, VIRGINIA 22314-1650
703/739-3850 FAX 703/739-3230

January 18, 1991

Mr. Mark Richer
Chairman, SS/WP-2
c/o PBS
1320 Braddock Place
Alexandria, Virginia 22314

Dear Mark:

With the increased emphasis upon all-digital solutions to ATV transmission, and as many as four out of five Simulcast systems all-digital, several substantial issues arise affecting the Test Procedures Plan, the work of the laboratories, and the daily schedule for testing. These are identified below with recommended changes to the Test Plan where appropriate, as well as the impact on the laboratories' plans.

We recommend that SS/WP-2 can take action to address these matters at the meeting of January 18.

1. Effect of Hysteresis on Power Level Determination and Threshold of Visibility/Point of Unusability Procedures

Digital TV systems are expected to exhibit hysteresis between the C/N at which the receiver can acquire (synchronize to) the signal and a lower value of C/N below which reception ceases (loss of synchronization). The difference between these two C/N levels is the noise hysteresis of the system.

Among the first steps in testing a Simulcast ATV system is determination of the power levels at which the robustness of the system will be tested. A "Weak" level is found experimentally, and two higher levels are calculated with respect to the Weak Level. Section 19.2.3 specifies the procedure for finding the Weak signal level, which is the noise threshold. Starting at a level at which noise-free reception is obtained, the signal power is reduced until reception is impaired. If the system under test does not have noise hysteresis, then the direction from which this threshold is approached will not matter. Given hysteresis, however, the threshold determined in the specified manner may be below the level at which reception would commence if the procedure were begun from the opposite direction. The attached figure shows a hypothetical hysteresis curve, indicating the different C/N levels at which signal acquisition and loss of lock occur. It is important that the higher of the signal acquisition and loss of lock occur. It is important that the higher of the two signal levels be the "Weak" level to be reported from this procedure. Obviously, a level that is below the acquisition threshold is useless in subsequent testing.

We recommend that the procedure of Section 19.2.3 be amended to specify that, in the event hysteresis is found, the higher of the two levels (i.e., the level corresponding to signal acquisition) be reported as the "Weak" signal level. The magnitude of the hysteresis also should be reported for the record. The hysteresis is of interest since, once the receiver has acquired a weak desired signal, the level of that desired signal may fade.

Hysteresis is also a factor in procedures that involve expert determination of Threshold of Visibility (TOV) and Point of Unusability (POU). In particular, it is important that the POU be approached from a level of impairment sufficiently high that the receiver cannot acquire the signal. Then, the reported POU would be the level at which acquisition first occurs, provided that the experts deem the reception "usable" at that level. Otherwise, the POU would be the slightly lower impairment level at which reception just becomes usable. The TOV would be the level beyond which no further improvement in reception occurs as the impairment level is decreased. If the reported TOV and POU are converged upon iteratively, approaching them alternately from each direction, then care must be taken that the reported levels are within the range between the acquisition threshold and the level at which no further improvement in reception occurs (i.e., that the reported levels are not between the acquisition threshold and the level at which there is loss of lock).

It may be desired to add the hysteresis as a third datum, besides "TOV" and "POU," to be reported for each impairment and interference test. The hysteresis would be of interest since the desired signal may fade or the interfering signal may increase as reception is taking place. (In an extreme case, an interfering ATV signal might increase to a level at which it would "capture" the receiver, as in FM reception. In our testing, such an occurrence of capture would be difficult to detect since both ATV signals are modulated identically.) While we are raising this issue for consideration by SS/WP-2, we cannot commit to providing this additional data routinely, for every test, since the additional testing time required to confirm and record the magnitude of the hysteresis is unknown.

It should be noted that the time required for signal acquisition to occur at high impairment levels may be substantially longer than the acquisition time with little impairment. The procedure for determining the acquisition threshold must specify a maximum time to be allowed. This specification should take into account the length of time a consumer would wait for a receiver to acquire a new signal when the channel is changed. We recommend that SS/WP-2 request that SS/WP-1 determine the approximate acquisition threshold and acquisition time for each system. In the absence of guidance from

SS/WP-2, the testing laboratory will exercise its discretion as to waiting time for acquisition. Inasmuch as the acquisition threshold is equivalent to the POU, as explained in an earlier paragraph, we recommend that the procedure for finding POU for a digital system having hysteresis be as follows:

> Begin with the undesired signal at a level too high for acquisition to occur (the "starting" level for this procedure). Switch the attenuator to the first undesired level to be tried. Wait for a predetermined time. At the end of this time, the expert observers declare whether acquisition has occurred. If not, then return the attenuator to the starting level. Then switch the attenuator to the next level to be tried. Continue until the level is reached at which the experts observe that acquisition occurs within the allowed time. This level is the reported acquisition level.

2. <u>Effect of "Quasi-bi-stable" Performance on Ranging Procedures</u>

Analog systems show variation in performance with varying levels of transmission impairment and interference over a wide range, at least 20 dB. Digital systems may show variation over a very small range between the signal acquisition threshold and a level, only a few dB away, beyond which there is no further improvement in reception. Such performance may be called "bi-stable." It is likely that this range will be smaller than the expected variation in signal level, especially in the outer reaches of the service area. There is little point in making rating tapes and conducting non-expert subjective tests over such a small range of levels. Instead, the results of the ranging procedure should be reported as "Expert Observation and Comment" only.

We recommend that the Test Plan permit this simplification when small ranges are found. Guidance should be sought from PS/WP-3 as to an appropriate specification for "small", taking into account the field strength variations likely to be encountered in practice. In the absence of such guidance, the testing laboratory will exercise its discretion as to the appropriate method to be used.

3. <u>Effect of Channel Equalizer Characteristics on Multipath and Multiple-Microreflection Testing</u>

Digital systems incorporate adaptive channel equalizers, which function as group-delay correctors and ghost cancellers. These equalizers may be able to remove the effects of weak reflections, but they may be unable to cope with strong reflections. Strong, close-in echo can arise from the poor VSWR of the ATV receiver or summation of multiple microreflections in the cable distribution plant. Adaptive equalizers may also exhibit hysteresis. Therefore, the concerns expressed in Paragraph 3, above, with regard to the directionality of approach in finding TOV and POU, also apply to the multipath and multiple-microreflection procedures. Specifically, the maximum echo amplitude (at a given delay) for which the system can correct should be approached from a high amplitude of echo, beyond the correction range.

We recommend that this tutorial amendment be made to the Test Plan.

4. Power Measurement for Simulcast Systems

The revised procedure for determining the "Weak" signal level for Simulcast systems, which was approved by SS/WP-2 on 12/3/90, specifies that the "most sensitive picture" be used. It is likely that the all-digital systems will have constant, time-invariant, radiated power, which will be independent of picture content, motion, color, etc.

It is important that SS/WP-1 verify this assumption for each of the all-digital systems as soon as possible. If valid, it would permit simplification of the procedure for those systems, since the exercise of finding the "most sensitive picture" would be unnecessary.

In addition to the specific concerns raised in the above paragraphs, we would like to express a general concern regarding all-digital systems. Since an appropriate test methodology may vary significantly from one system to the next, the concept of "system-specific" testing should receive increased emphasis. From what we already know about such systems but, more importantly, because of what we don't know about them, we doubt seriously that the one day reserved for system-specific tests will be adequate. There is no other time available during the test slot unless some of the other tests can be dropped or greatly simplified on a system-specific basis. We urge that guidance be provided to the laboratories by SS/WP-2 and by the SS/WP-1 Analysis Task Force.

In conclusion, we would like to emphasize a point that we have made on several previous occasions. Until we have conducted dry runs of our facilities and of the approved test procedures, the test laboratories cannot commit to conducting all of those procedures within the time allowed. As we enter the dry-run phase of our preparations for testing, we will advise SS/WP-2 of any recommended or necessary changes to the approved procedures in order to achieve our mutual goals.

Sincerely,

T. M. Gurley
for CWR

Charles W. Rhodes
Chief Scientist
ATTC

Brian James
Director, Advanced Television Testing
CableLabs

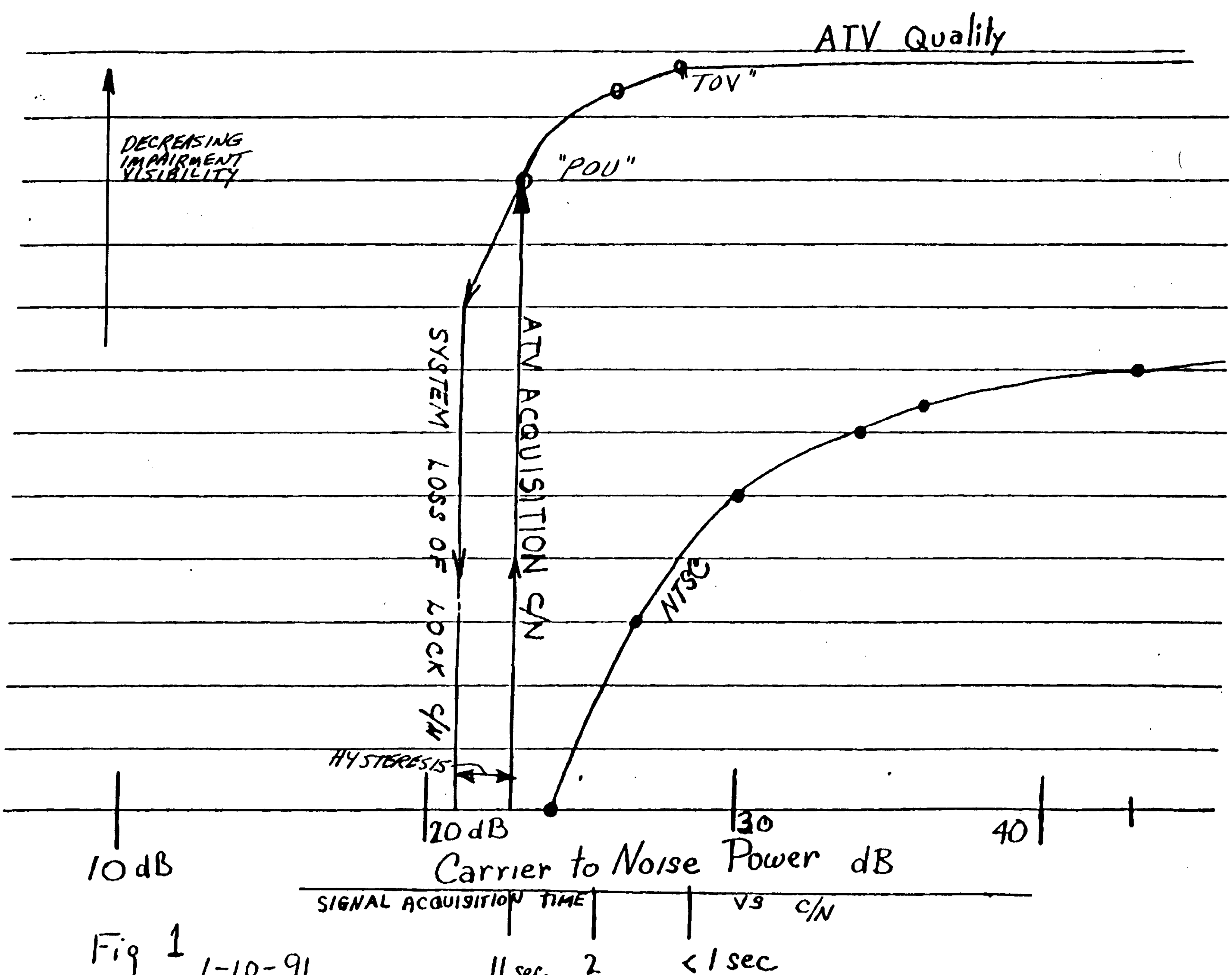
ATV Quality
"TOV"
"POU"
DECREASING IMPAIRMENT VISIBILITY
SYSTEM LOSS OF LOCK C/N
ATV ACQUISITION C/N
NTSC
HYSTERESIS
10 dB
20 dB
30
40
Carrier to Noise Power dB
SIGNAL ACQUISITION TIME VS C/N
11 sec
2
< 1 sec

Fig 1 1-10-91

ZENITH

ZENITH ELECTRONICS CORPORATION □ 1000 MILWAUKEE AVENUE □ GLENVIEW, ILLINOIS 60025-2493

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SSWP2-0623
15 JAN 91

January 14, 1991

Mr. Mark Richer
Chairman SS/WP-2
PBS
1320 Braddock Place
Alexandria, Virginia 22314

RE: The Need To Be Able To Change ATV Test Procedures

Dear Mark:

Confirming a recent telephone conversation, we need to take whatever steps are necessary to assure completeness of the testing procedures to be used by the various ATV testing labs. It needs to be understood by all, that as the proponents begin to bring actual functional hardware to life, we all will learn concepts which have not been apparent in the past. As I believe it was Bernie Dayton that mentioned at a past Systems Subcommittee meeting, we are not dealing with product developments but rather with R&D efforts. This is particularly true in the area of all-digital HDTV systems as now proposed. Dr. Carnes of Sarnoff mentioned at the recent proponents meeting that he too saw the need of including testing procedures that were appropriate, and perhaps, unique, to all digital systems.

The purpose of this correspondence is twofold. First, to underscore the need for maintaining flexibility relative to test procedures. Again, a good example (but not the only example) is the emergence of all-digital systems.

The second purpose is to specifically request changes in the test procedures to include the new attributes which were added by PS/WP-1 and PS/WP-2 at their October 8, 1990 meeting. These attributes, specifically 1.4.1 and 1.4.2, relate to artifacts associated with motion detection and, most importantly, with additive noise source materials.

Especially with respect to the need for incorporating noisy source materials, Zenith (and others including NBC and CBS) supported such action by PS/WP-1 and PS/WP-2. The Zenith letter is enclosed hereto. The other supporting letters were attached to the October 8, 1990 minutes (not enclosed herein).

In the way of background for the need to test with noisy sources, we enclose two documents which were submitted to PS/WP-6 relative to their need to utilize cameras with equal noise performance during the production of the subjective source material. These documents authored by Professor Jae Lim of MIT and Dr. Arun Netravali of AT&T Bell Labs, provide a background for compression considerations when less than an ideal source environment exists.

Specifically, Zenith is requesting the following:

(1) Tests be added to the existing test procedures which include attributes 1.4.1 and 1.4.2 of the list provided by PS/WP-1 and PS/WP-2; and

(2) that this letter and its enclosures be shared with all members of SS/WP-2 and become part of the official record.

We thank you in advance for your consideration.

Sincerely,

WCL/e

Enclosures

cc: B. Dayton
I. Dorros

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS 02139

December 28, 1990

Craig K. Tanner, Chairman
Working Party 6 of the
Planning Subcommittee of the
FCC Advisory Committee
c/o Cable Television Laboratories, Inc.
1050 Walnut Street, Suite 500
Boulder, CO 80302

Dear Mr. Tanner,

I am writing this letter concerning the source material to be used for ATTC testing. Since I did not attend WP-6 meetings, this letter is based on the minutes of WP-6 meetings.

The ATTC testing is intended to provide the best delivery system for the future HDTV in the United States. Therefore it is important to use the source material which best serves the intended purpose. I have the following comments concerning the source material.

1. The characteristics of a camera system that affect the quality of the source material can be classified into two classes. The first class involves the characteristics that are an integral part of the delivery system. Examples of this class include progressive scanning/interlaced scanning, the number of lines, the number of picture elements/line, etc. These choices are consciously made by the system designer to maximize the quality of the video that can be transmitted within a 6 MHz channel. Once the HDTV standard is determined, these characteristics do not change and future camera improvements will not affect them. If a system designer has developed a way to transmit 4000 lines within a 6 MHz channel, for example, the source material that has 4000 lines should be provided to the extent current technology allows. The difference in the quality of the source material that results from the designer's conscious choice should be reflected in the source material used.

   The second class involves the camera characteristics that are not an integral part of the delivery system. Examples of this class include the noise level, camera sensitivity, etc. These characteristics are not chosen by the system designer. In fact, every system designer wishes to have the least level of noise and the maximum camera sensitivity to maximize the quality of the video that can be transmitted within a 6 MHz channel.

This second class of characteristics will improve over time and does not affect the HDTV standard. In generating the source material this second class of characteristics has to be made as equal as possible to the extent that they affect the quality of the source material.

2. According to Zenith Corporation, the noise characteristics of the BTS camera are significantly worse than the new SONY camera. If this is true, it is my opinion that extreme care should be exercised in using these two different cameras to generate the source material.

   Video encoding methods used by MIT, General Instrument, and Zenith Corporation rely very heavily on particular types of temporal (frame-to-frame) and spatial correlation that are present in typical video material. The noise typically has very little temporal or spatial correlation. Even when there is some, the characteristics are quite different from those exploited in the video compression methods. As a result, these video compression methods waste significant bandwidth in encoding the noise in the noisy source material.

   The delivery system that uses the source material originated from the BTS camera, therefore, will be at a clear disadvantage relative to a system that uses the source material originated from the new SONY Camera. A consequence of this may be that we choose an inferior delivery system as the HDTV Standard. This clearly is not in the best interest of the United States.

Based on the above, it is my opinion that the inequality due to the camera noise characteristics should be eliminated in generating the source material.

Thank you for your consideration.

Sincerely,

Jae S. Lim
Professor of Electrical Engineering
Director of Advanced Television
Research Program

AT&T

Arun N. Netravali
Director
Computing Systems Research
Laboratory

600 Mountain Avenue
Room 3D-406
Murray Hill NJ 07974-2070
201 582-4131

December 31, 1990

Mr. Craig Tanner
Chairman, PS/WP-6
c/o CableLabs
1050 Walnut Street
Boulder, Colorado 80302

Dear Craig:

I have recently learned that input sequences with different amount of noise might get used to test the compression algorithms used by different HDTV proponents. I believe that this would result in a biased comparison as I have explained in the attached note. Please let me know if further elaboration is required. If there is, I will be happy to do so.

Sincerely,

Arun Netravali

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To B.L. Dickinson	From A.N. Netravali
Co. CBS	Co. AT+T BL
Dept.	Phone # (908) 582-4131
Fax # (212) 975-1715	Fax # (908) 582-5192

Source Noise and Compression

Several schemes are being proposed for compression of the High Definition Television Signal (HDTV). It is anticipated that the uncompressed HDTV signal will generate between 500 Mbits/sec to 900 Mbits/sec depending on the scanning format employed. This will have to be compressed to approximately 15 Mbits/sec to 20 Mbits/sec for terrestrial broadcasting within the 6 MHz bandwidth. The compression systems developed by different proponents employ a variety of techniques. These techniques are highly adaptive, and their performance depends upon the characteristics of the pictures, such as the type of correlations (spatial, temporal, amplitude, ...) present, perceptually significant detail in the images and the characteristics of noise within a television frame and from frame to frame. In order to make a fair comparison between the different schemes, it is important to keep constant as many parameters of the input sequences as possible: i.e., each scheme should be tested in as similar an environment as possible. One of the important components of the environment is the noise in the input source material.

Compared to the video coding for other applications such as video conferencing, coding of the HDTV signal has to be extremely high quality: almost transparent with the coding artifacts below the threshold of perceptual visibility for a large class of pictures typical of what may be used for entertainment, news, live sports, and other applications. For such a high quality coding, noise in the source material can bias the results quite substantially, since to maintain high quality one may end up coding noise because distinguishing noise from the real detail in images is extremely difficult even for the human eye. If the compression scheme is thought of as a collection of properly integrated techniques from a bag of techniques, then it is required to understand the effect of noise on each of the techniques employed. While the set of techniques is very large, it appears that the following techniques are used by most of the proponents.

a) Motion Estimation

Here noise in the source material can result in wrong matches to give erroneous motion vectors resulting in larger motion compensated prediction errors. This will reduce the quality of coded pictures and will also cause increase in bits required to transmit the motion vectors.

b) Transform Coding of Motion Compensated Prediction Error

Much of the source noise is usually high frequency and, therefore, it will corrupt most of the higher order coefficients. It will increase the variance of these coefficients requiring them to be transmitted more often. This will decrease the picture quality for a given bit rate.

c) Adaptive Quantization and Selection of Transform Coefficients.

Here, a larger number of coefficients will get selected for transmission, and if this raises the instantaneous bit rate too much, it will cause coarser quantization of coefficients giving poorer quality pictures.

As a rough measure of what source noise can do, consider uniformly distributed noise in the range [0,A]. The temporal differencing (due to motion compensation) will increase the range to [-A, +A]. Assume that the noise affects only p% of the transform coefficients. If a 'L' bit quantizer is used, then the smallest quantization level for the range [-A, A] is $2^{-L}(2A)$, and in this case, the noise will contribute (2 L.p)% additional bits. As a representative example, if the smallest quantization level is 1/255 (on an 8 bit scale) and the noise is uniformly distributed in [0,2], then for a p=5%, we have an additional 1/10 bits/pixel due to noise. If the pixel rate is about 60Mpixels/sec, then the noise will consume 6.0Mbit/sec., which is a significant fraction of the total allowable bit rate of around 15 Mbits/sec. This can cause serious degradation in the picture.

To evaluate the impact of the source noise experimentally, pictures were coded with artificially inserted noise in the original (noise free) pictures. This noise was uniformly distributed in the range [0, A], A being a controllable parameter. Several values of A were tried. In each case, comparisons were made between the original picture, coded-original picture and the coded, noise corrupted picture. Difference between the coded pictures with and without noise was quite visible even when the parameter A was 1 (out of a scale 0-255). This difference was comparable to the difference between the uncoded pictures with and without noise. Photographs are not provided since the process of photography introduces its own artifacts. However, a demonstration can be arranged to view these pictures on the display system.

It is difficult to quantitatively estimate the impact of source noise on different coding algorithms. However, it is clear that the impact is substantial and therefore, fair comparison can be made if every effort is made to keep the source noise constant.

Arun N. Netravali
AT&T Bell Laboratories

PS/WP1&2-077

ZENITH ELECTRONICS CORPORATION □ 1000 MILWAUKEE AVENUE □ GLENVIEW, ILLINOIS 60025-2493 □ (708) 391-7000

VIA FAX

October 8, 1990

Renville McMann, Chairman PS/WP1
c/o Alan Godber
NBC
30 Rockefeller Plaza
New York, N.Y., 10112
FAX: (212) 581-6687

Dear Ren,

We regret that Zenith cannot send a representative to the combined PS/WP1 & PS/WP2 meeting today in New York. The work and contribution of your group is vital for the selection of the best ATV system for the U.S.

According to the draft agenda sent out with today's meeting notice, you will be considering the addition of attributes which describe the effects of preprocessing and source noise on input signals to ATV systems. We are sending you this letter to express Zenith's support for testing ATV systems using both preprocessed images and images with source noise.

Preprocessing has become a common and important tool in television production. Inserts, special effects, editing, cuts, fades, etc., truly enhance the viewing experience of the public. Since these techniques can result in scenes which are not found naturally, it is totally possible that they may trigger artifacts from an ATV system which might otherwise go undetected. ATV systems are generally nonlinear systems which can react in surprising ways to unusual inputs.

The nonlinear processing of ATV systems can also respond in unusual ways to noisy inputs. To test this attribute, a single input signal should be tested with various degrees of additive noise and the results observed for the nature of a system's degradation.

We urge that your meeting come to the same conclusions and request that Zenith's opinion in this matter become a part the record for your meeting today.

Sincerely,

Ronald Lee

Ronald Lee

cc: C. Eilers - C. Heuer - W. Luplow

SSWP2-0638
29 JAN 91

To: Mark Richer
Chairman SS/WP2
c/o PBS
1320 Braddock Place
Alexandria VA 22314

January 28, 1991.

Subject: Change/Modifications to ATTC Test Procedures.

Dear Mr. Richer:

On behalf of the Advanced Television Research Consortium (ATRC,) we would like to use the opportunity offered us during the meeting of SS/WP2 on January 18, 1991, to submit our recommendations for some changes in the ATV test procedures for digital ATV systems.

The changes that we proposed are described in the enclosed document. We hope that the proposed changes, together with those from other proponents, will help make the digital ATV systems test results more meaningful.

Sincerely,

Sheau-Bao Ng
David Sarnoff Research Center

C.A.A.J. Greebe
Philips Laboratories Briarcliff

Copy (with encl.) to:

B. Caron (CRC)
P. Fannon (ATTC)
K. Kubota (NHK)
W. Luplow (Zenith)
C. Rhodes (ATTC)
J. Cohen (WP2: Field Tests)
R. Green (CableLabs)
J. Lim (MIT)
R. Rast (General Instrument)
G. Tanner (Chairman, WP/6)

SBN/sbn
Encl.

In consideration of the significant majority of digital ATV systems scheduled for testing by the ATTC, the Advanced Television Research Consortium (ATRC) is recommending modifications to the test procedures described in the document *SSWP2-0189*[1]. We feel that these modifications are necessary because of the significant and fundamental difference in approaches between an analog ATV system and a digital ATV system. To accomplish the stated intent of these test procedures, some aspects in the current test procedures would require changes. As these modifications only concern test materials, they are also applicable to the Cable Television Transmission Tests manual (document *SSWP2-0357*.)

A main reason for the need to modify the test procedure is that most digital ATV systems employ statistical data compression that exploits spatial and/or temporal redundancy present in the pictures. In addition, digital video compression systems have the ability to dynamically distribute the available channel resources among the spatial, (horizontal, vertical, or any other spatial orientation,) and the temporal performance. Therefore a test procedure to measure the performance of a digital ATV system in any one particular (spatial or temporal) orientation must ensure that the system does not unrealistically allocate *all* the available channel resources toward its performance in that particular orientation for that particular test. Consider, as an example, a test procedure to measure the static spatial resolution of a system. Using static test patterns, however complex, as the test pictures, provides the system under test (SUT) an unusually favorable condition because all the channel resources can be allocated for the spatial rendition of the image since the temporal redundancy in the test picture is absolute.

While the test procedures described in [1] are equally applicable to both analog and digital ATV systems, more insight of digital ATV system performance is possible from some of these test procedures if some modifications are introduced.

Image Resolution and Transient Response Test Procedures

The changes proposed here apply to the Image Resolution and the Transient Response test procedures described in chapters 1 and 3 of [1].

Figure 1 illustrates the general appearance of the test picture proposed by ATRC to be used in the Resolution and the Transient Response test procedures. There are two basic components in the test picture: (1) the circularly-shaped area called the *measurement zone* and (2) the background area called the *load zone*.

The purpose of the *load zone* is to provide sufficient load to the video compression system so that the tests and measurements taken within the *measurement zone* are indicative of the performance of the SUT under realistic conditions.

The ratio of the areas occupied by the two zones, hereafter called the *load-to-measurement ratio*, and the location of the *measurement zone*, provide further test controls. By choosing different load-to-measurement ratios, the system is subjected to different levels of stress. The associated measurements are therefore indicative of the potentially different performance of the SUT under different operating modes/states. For example, a load-to-measurement ratio of 1:10 may be a light load, while a 10:1 may represent an extremely stressful load on the SUT.

The *load zone* shall contain white (Gaussian) noise of a specified variance. The variance, or equivalently the noise power, should be sufficiently high that the noise causes desirable loading of the SUT. Because of the sophisticated motion algorithms that are likely to be used in a digital ATV system, it is important that the noise vary in both the spatial and the temporal directions, i.e., a "moving" white noise pattern rather than a fixed (albeit random) noise pattern. The picture within the *measurement zone* shall be the test picture described in [1] for the Image Resolution and the Transient Response measurements.

It should be remarked here that the transition from the *load zone* to the *measurement zone* can provide some potentially useful data.

Figure 2 shows the proposed test picture for the Image Resolution tests. The *measurement zone* depicts a circular zone plate as shown in Figure 1-1 of the WP2 document [1]. Figure 3 shows the proposed test scene for the horizontal and vertical transient response tests. The areas marked C1, C2, C3, and C4 correspond to the same areas in Figure 3-2 of [1]. For the measurement of the temporal transient response, Figure 4 shows the test picture after the Radial Resolution Test Pattern (Figure 3-3 of [1]) has been gated into the *measurement zone*. The test picture before the test pattern has been gated in would have a flat field for the *measurement zone*.

To allow the maximum spatial frequency of the test patterns (circular zone plate or the radial resolution chart) to be in the *measurement zone*, it may be necessary to shift the center of the test pattern away from the center of the *measurement zone*. Alternative arrangement of the two zones in a test picture can be used. An example of an alternative arrangement is shown in Figure 5. The *load zone* covers the four corners of the picture, while the remaining area is used for the *measurement zone*. The arrangement of the four *load zones* can be selected such any desired resolution on the circular zone plate is depicted within the *measurement zone*. It is desirable that the shape of the *measurement zone* be non-rectangular to avoid the event that the zone border(s) may coincide with any block structure that is introduced by the video compression system. Toward that end, a circular *measurement zone* is desirable.

Other Remarks

Regarding the multipath susceptibility test (Section 19.4 of [1]) it is recommended that the evaluation of the threshold sensitivity be made based on not only the appearance/visibility of any (leading or lagging) ghost images but also any visible picture degradation. For digital ATV systems with digital transmission, the effect of a multipath channel, in general, will not be the appearance of a replicated signal at the display.

Regarding the issue of noisy source material, the ATRC recommends that for the test procedures using camera-source pictures, the amount of camera noise or otherwise source noise be noted for the record and be included in the sub-section called Presentation of Data in that particular procedure description.

REFERENCE

[1] ATV Test Procedure: Objective and Transmission Tests (SSWP2-0189), 28 Sep 90.

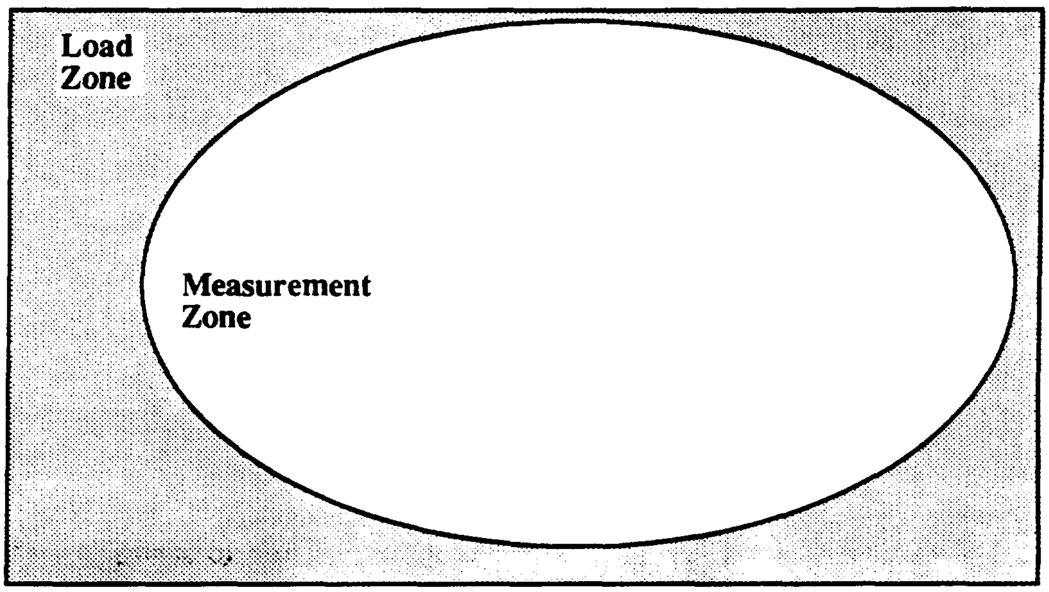

Figure 1: Proposed Test Picture

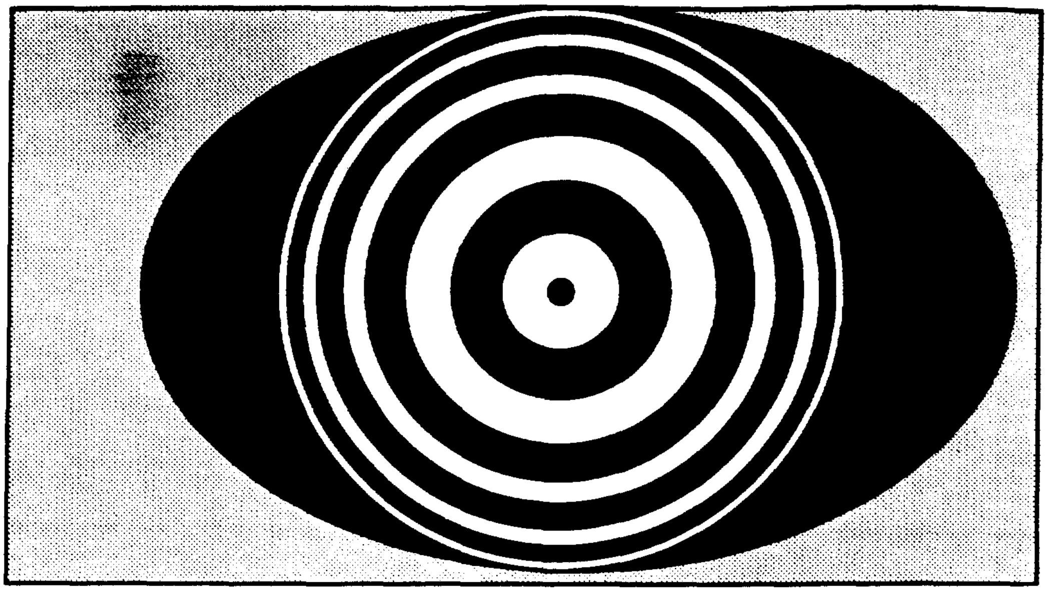

Figure 2: Proposed Test Picture for Image Resolution Measurement.

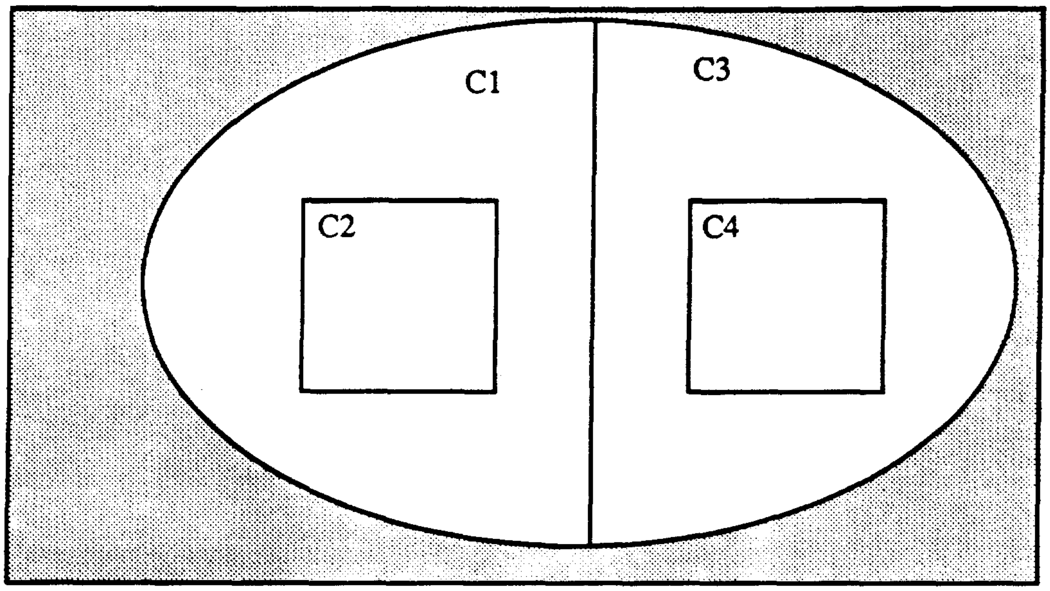

Figure 3: Proposed Test Picture for Transient Response Measurement.

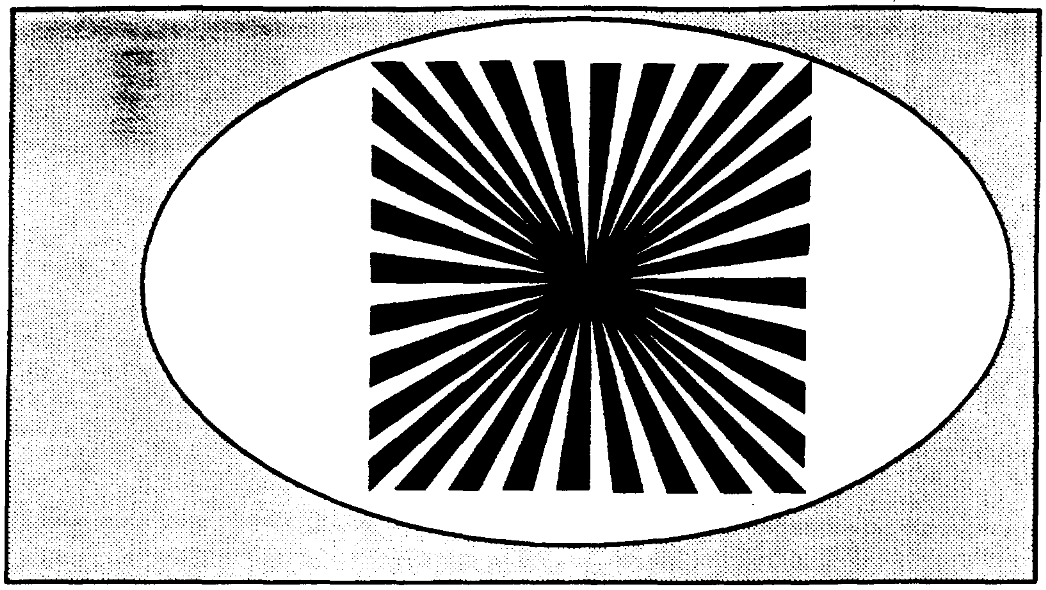

Figure 4: Proposed Test Picture for Radial Resolution Test Pattern.

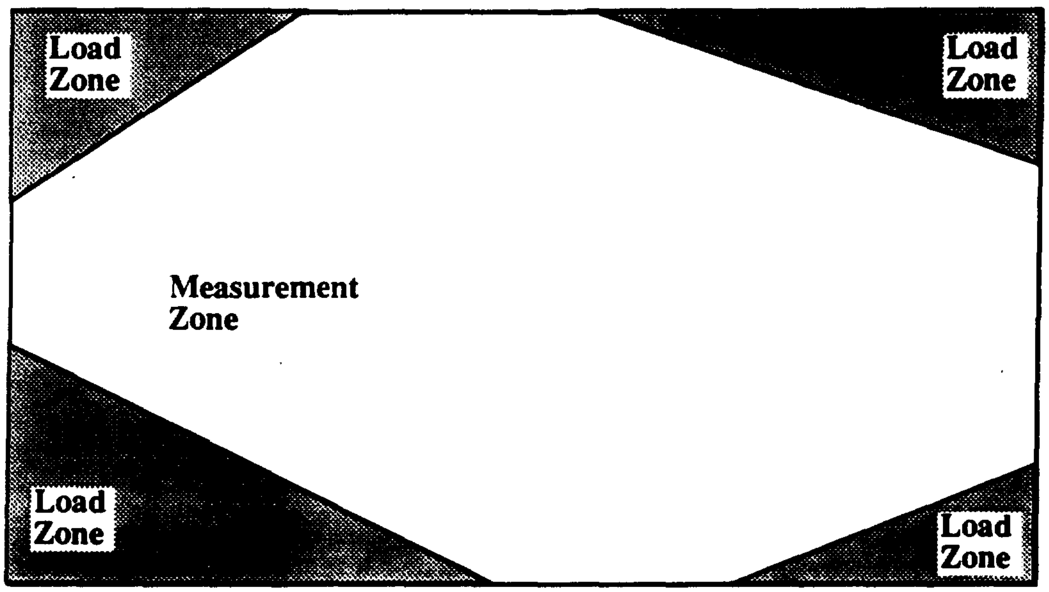

Figure 5: Alternative Load and Measurement Zone Arrangement.

TAB

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APPENDIX X

January 21, 1991

Mr. Mark Richer
Chairman, SS/WP-2
PBS
1320 Braddock Place
Alexandria, Virginia 22314

SSWP2-0630
23 JAN 91

Dear Mark:

At the meeting of SS/WP2 on 1/18/91, you asked for written responses from proponents on the question of whether generic testing of digital transmission systems is appropriate. Apparently the suggestion has been made that, if all digital simulcast proponents are using 16-QAM or some minor variant thereof, a common test of digital transmission could be undertaken before specific testing of complete systems began. There was hope that channel characterization and the collection of error statistics would be shared and useful knowledge for all digital systems.

The ATRC believes that such generic testing is not appropriate because it will not serve the purpose for which it is intended. Proponents and the testing process must determine the coverage area (and associated allocations and interference) over which acceptable digital HDTV video and audio can be delivered. This will not be learned simply from measurements of the error statistics of 16-QAM because both source and channel coding impact the quality of the recovered image. Thus the effects of noise, interference, and multipath must be measured on the complete system, not just on a generic method of modulation.

Since general characterization of the transmission of 16-QAM will not allow meaningful extrapolation to digital HDTV transmission effectiveness, ATRC urges that it not be undertaken. It is not a useful expenditure of proponents' or ACATS' resources.

Very truly yours,

John

John G.N. Henderson
David Sarnoff Research Center